INDOOR DIOXIN ASSESSMENT REPORT

SITE NAME:	Ringwood Mines Landfill Site – RV001
DC NO.:	RST 2-02-F-2664
TDD NO.:	TO-0029-0014
EPA SITE ID NO.:	NJD980529739
SAMPLING DATES:	February 13, 2012

1. Sample Locations: Refer to Attachment A, Table 1, Wipe Sample Collection Information Table

2. Introduction:

In 2012, The United States Environmental Protection Agency's (EPA) Removal Action Branch was requested to assess residential properties for the presence of dioxin and related compounds in the vicinity of the Ringwood Mines Superfund Site (the Site). The justification for the Indoor Dioxin Assessments was based upon historical landfill fires during the deposition of wastes at the Site and the possible aerial deposition of particulates on to surrounding residential properties. As a result, residents requested that EPA conduct voluntary indoor residential dioxin testing to determine if any residential properties had been impacted by previous operations conducted at the Site.

This report has been prepared to document the activities which were completed in support of the Indoor Dioxin Assessment. For privacy reasons, the name and address of this property will not appear within this report. Instead the property was assigned a unique identifier number - RV001.

3. Indoor Dioxin Assessment Summary:

On February 13, 2012, Weston Solutions, Inc., Removal Support Team 2 (RST 2) mobilized to the Site to conduct Indoor Dioxin Assessment sampling activities at the property referred to by RST 2 as RV001. Sampling was conducted in accordance with the EPA Environmental Response Team (ERT) Standard Operating Procedure (SOP): *#2011, Chip, Wipe, and Sweep Sampling*, dated November 1994. Two sample locations were chosen: one in a high occupancy area (i.e., the living room) and one in the attic. Dioxins refer to a group of toxic chemical compounds that share certain chemical structures and biological characteristics. Dioxins can be released into the environment through forest fires, backyard burning of trash, certain industrial activities, and residue from past commercial burning of waste. Dioxins breakdown very slowly and past releases of dioxin from both man-made and natural sources still exist in the environment. Other sources include the incomplete combustion of firewood or cooking oils and grease; therefore, areas where combustion may occur, such as kitchens and fireplaces, were avoided. The attic was chosen as a sample location because of the presence of air circulation vents open the exterior of the residence, which may have become collection areas of external smoke from the landfill fires.

The wipe samples were collected by surrounding an area with a 100 square centimeter (cm^2) template and wiping the area with a 15-cm by 15-cm Ghost Wipe™ sterile sampling pad soaked with hexane. The surface area sampled was wiped vertically and then horizontally to ensure complete surface coverage for sample collection. The wipe samples were then placed in 2-oz. glass jar for shipment to the laboratory. As part of the Indoor Dioxin Assessment sampling activities conducted on February 23, 2012, RST 2 collected two wipe samples from the RV001 property. The wipe samples collected from RV001 on February 23, 2012 were shipped to an EPA Contract Laboratory Program (CLP) laboratory, Cape Fear Analytical, LLC of Wilmington, North Carolina, on February 23, 2012 for dioxin/furan analysis under Chain of Custody (COC) Record No. 2-021312-144957-0019. Wipe sample collection information can be found in Attachment A, Table 1. In addition, photographic documentation can be found in Attachment B. The COC Record is presented in Attachment C.

4. Analytical Discussion

Dioxins are a group of compounds that share distinct chemical structures and characteristics. The term "dioxin" commonly refers to the compound in this group considered most toxic, 2,3,7,8-tetrachlorodibenzo-para-dioxin (2,3,7,8-TCDD). Other dioxin-like compounds (DLCs) are typically found in combination with 2,3,7,8-TCDD. Toxicity Equivalence Factors (TEFs) are used as a measure of toxicity of DLCs relative to 2,3,7,8-TCDD. Concentrations of DLCs in environmental media are modified by TEFs to determine the concentration of each DLC that is equivalent to a concentration of 2,3,7,8-TCDD. The modified DLC concentrations are expressed in terms of 2,3,7,8-TCDD toxicity equivalence (TEQ) (i.e., dioxin). An EPA Fact Sheet: Use of Dioxin TEFs in Calculating Dioxin TEQs at CERCLA and RCRA Sites, is presented in Attachment D.

Analytical results of the wipe samples collected on February 13, 2012 indicated Total 2,3,7,8-TCDD TEQs of 0.77 nanograms per square meter (ng/m^2) and 0.58 ng/m^2. All sample results were compared to the EPA Risk Assessment Screening Value of 0.9 ng/m^2. Sample analytical results indicated that dioxin concentrations were below the 0.9 ng/m^2 screening value. Refer to Attachment A, Table 2 for the 2,3,7,8-TCDD Toxicity Equivalence Summary Table and Attachment C for the validated laboratory data.

5. Report Prepared By: _____ Date 1/6/14
Scott T. Snyder, CHMM
Site Project Manager, RST 2

6. Report Reviewed By: _____ Date 1/6/14
Peter Lisichenko
Group Leader, RST 2

ATTACHMENT A

- Table 1: Wipe Sample Collection Information Table (RV001)
- Table 2: 2,3,7,8-TCDD Toxicity Equivalence Summary Table (RV001)

Table 1
Wipe Sample Collection Information Table
Ringwood Mines Landfill Site (RV001)
February 13, 2012

Sample No.	Sample Date	Sample Time	Media	Analysis	Collection	Sample Type	Location Description
RV001-FW001-001	2/13/2012	0945	Wipe	Dioxins/Furans	Grab	Field Sample	Attic
RV001-FW002-001	2/13/2013	0955	Wipe	Dioxins/Furans	Grab	Field Sample	Living room
RV001-FB-021312	2/13/2012	0948	Wipe	Dioxins/Furans	Grab	Field Blank	N/A
RV001-LB-021312	2/13/2012	0957	Wipe	Dioxins/Furans	Grab	Lot Blank	N/A

N/A = Not applicable.

Table 2
2,3,7,8-TCDD Toxicity Equivalence Summary Table
Interior Wipe Samples
Ringwood Mines Landfill Site (RV001)
February 2012

Field Sample ID:	**RV001-FW001-001**	**RV001-FW002-001**
Sample Date:	**2/13/2012**	**2/13/2012**
CLP Sample ID:	**B9NN7**	**B9NN8**
Comment:	**Attic**	**Living Room**
Total 2,3,7,8-TCDD TEQ*	0.77	0.58

All concentrations presented in nanograms per square meter (ng/m^2).

CLP = Contract Laboratory Program.

TCDD = Tetrochlorodibenzo-para-dioxin.

TEQ = Dioxin toxicity equivalence.

*World Health Organization (WHO) 2005 Toxicity Equivalence Factors (TEFs) used to calculate Total 2,3,7,8-TCDD TEQ.

ATTACHMENT B

- Photographic Documentation

Photographic Documentation
Ringwood Mines Landfill Site
Indoor Dioxin Assessment – RV001
February 13, 2012

Photograph No. 1: Wipe Sample Location RV001-FW001-001, adjacent to attic access hatch.

Photograph No. 2: Wide angle view of RV001 attic.

Photographic Documentation
Ringwood Mines Landfill Site
Indoor Dioxin Assessment – RV001
February 13, 2012

Photograph No. 3: Wipe sample location RV001-FW002-001, living room floor.

Photograph No. 4: Wide angle view of wipe sample location RV001-FW002-001.

ATTACHMENT C

o Chain of Custody Record and
Validated Laboratory Analytical Results

Weston Solutions, Inc., RST 2
Case #: 41826

CHAIN OF CUSTODY RECORD
Ringwood Mines Landfill - RV
Contact Name: Andy Confortini
Contact Phone: 908-420-4455

No: 2-021312-144957-0019
DateShipped: 2/13/2012
Lab:Cape Fear Analytical
Airbill No: 8993 5598 4330

Lab #	Sample #	CLP Sample #	Analyses	Matrix	Sample Media	Area	Area Units	Collected	Sample Time	Numb Cont	Container	Preservative	Lab QC
	RV001-FW001-001	B9NN7	Dioxins/Furans	Wipe	Gauze pad	100	centimeters	2/13/2012	09:45	1	4 oz jar	Hexane-4 C	N
	RV001-FW002-001	B9NN8	Dioxins/Furans	Wipe	Gauze pad	100	centimeters	2/13/2012	09:55	1	4 oz jar	Hexane-4 C	N
	RV001-FB-021312	B9NN9	Dioxins/Furans	Wipe	Gauze pad			2/13/2012	09:48	1	4 oz jar	4 C	N
	RV001-LB-021312	B9NP0	Dioxins/Furans	Wipe	Gauze pad			2/13/2012	09:57	1	4 oz jar	4 C	N

Special Instructions: Samples to be analyzed using method DLM02.2. Per the request of the Cape Fear Analytical laboratory coordinator, the gauze pads were moistened with hexane prior to collection. This is the last shipment of samples under this CLP Case No.

SAMPLES TRANSFERRED FROM
CHAIN OF CUSTODY #

Items/Reason	Relinquished by (Signature and Organization)	Date/Time	Received by (Signature and Organization)	Date/Time	Sample Condition Upon Receipt
All Samples	[signature]	2/13/12			

PCDD's & PCDF's by HRGC/HRMS

CASE No.: 41826
LABORATORY: CAPE
ANALYSIS: PCDD & PCDF

SDG No.: RS003-FB-021312
SITE: RINGWOOD MINES LF

DATA ASSESSMENT

The current SOP HW-19 (Revision 1) October 2006, USEPA Region II Data Validation SOP for evaluating organic data has been applied.

All data are valid and acceptable except those analytes rejected "R"(unusable). Due to the detection of QC problems, some analytes may have the "J" (estimated), "N"(presumptive evidence for the presence of the material), "U" (non-detect) or "JN" (presumptive evidence for the presence of the material at an estimated value) flag. All action is detailed on the attached sheets.

The "R" flag means that the associated value is unusable. In other words, significant data bias is evident and the reported analyte concentration is unreliable.

Reviewer's Signature: Shobitha Capil Date: 04 / 10 / 2012

Peer Reviewer's Signature: _____ Date: ____ / ____ / 2012

Verified By: _____ Date: ____ / ____ / 2012

PCDD's & PCDF's by HRGC/HRMS

SDG# FB-021312

Sample identification:
The following detected target analytes do not satisfy all method defined criteria (Ion Abundance Ratios) and have been reported as Estimated Maximum Possible concentration (EMPC):

LAB METHOD BLANK MB for batch 20476:
1234678-HpCDD, 12346789-OCDF

Sample # RS003-LB-031312 (B9NP8):
1234678-HpCDD

Sample # RS004-LB-021312 (B9NQ2):
1234678-HpCDD

Sample # RV003-FW002-001 (B9NP2)
1234678-HpCDF

Sample # RV003-LB-021312 (B9NP4):
2378-TCDF

Sample identification:
The following detected target analytes indicate the presence of a quantitative interference and have been qualified as Estimated J:

Sample # RS003-FW001-001 (B9NP5):
123478-HxCDF

Method Blank Contamination:

Reported analyte concentration in the sample is less than 5 times the concentration of the analyte in the method blank. Reported analyte concentration has been been reported as Estimated Maximum Possible concentration (EMPC):

12346789-OCDD in the following samples:
RS003-FW002-001 (B9NP6), RS004-FW001-001 (B9NP9), RS004-FW002-001 (B9NQ0) & RV003-FW001-001 (B9NP1), RV001-FW001-001 (B9NN7), RV001-FW002-001 (B9NN8), RV003-FW002-001 (B9NP2)

Field Blank Contamination:

Reported analyte concentration in the sample is less than 5 times the concentration of the analyte in the Field blank. Reported analyte concentration has been been reported as Estimated Maximum Possible concentration (EMPC):

PCDD's & PCDF's by HRGC/HRMS

2378-TCDF in the following samples:
RS003-FW001-001 (B9NP5), RS003-FW002-001 (B9NP6), RS004-FW001-001 (B9NP9), RV003-FW002-001 (B9NP2)

1234678-HpCDD
RS004-FW002-001 (B9NQ0) & RV003-FW001-001 (B9NP1), RV001-FW001-001 (B9NN7), RV001-FW002-001 (B9NN8), RV003-FW002-001 (B9NP2),

Sample # RS003-FW001-001 (B9NP5):
12346789-OCDD has been qualified J as the reported value is over the calibration range.

Internal Standard Recovery:
Internal standard recoveries are below the lower limit. Associated detected compounds are qualified J. Non detected compounds are qualified R.

Sample # RS004-FW001-001 (B9NP9):
13C-123478-HxCDF

Sample # RV001-FW001-001 (B9NN7):
13C-123478-HxCDF

Method Blank -MB for batch 20476:
13C-123478-HxCDF

LCS - LCS for batch 20476:
13C-123478-HxCDF

Sample # RS004-FW002-001 (B9NQ0) & RV003-FW001-001 (B9NP1):

Internal standard recoveries for 13C-12378-PeCDD, 13C-12378-PeCDF, 13C-23478-PeCDF are very low in the initial analysis. Both samples were re-analyzed at a 5X dilution. Recoveries were within QC limits in the dilution runs. Associated compounds are reported from the dilution runs.

Case No: 41826	Contract: EP10W001070	SDG No: RS003-FB-021312	Lab Code: CAPE
Sample Number: RV001-FB-021312	Method: Dioxin	Matrix: Soil	MA Number: 2196.0
Sample Location:	pH:	Sample Date: 02132012	Sample Time: 09:48:00
% Moisture :		% Solids : 100	

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
2,3,7,8-Tetrachlorodibenzo-p-dioxin	0.00118	ng/wipe	1	U	U	Yes	S2AVE
2,3,7,8-Tetrachlorodibenzofuran	0.0014	ng/wipe	1	J	J	Yes	S2AVE
1,2,3,7,8-Pentachlorodibenzofuran	0.00109	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	0.00134	ng/wipe	1	U	U	Yes	S2AVE
2,3,4,7,8-Pentachlorodibenzofuran	0.00104	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,7,8-Hexachlorodibenzofuran	0.00131	ng/wipe	1	U	R	Yes	S2AVE
1,2,3,6,7,8-Hexachlorodibenzofuran	0.00127	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.00236	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.00238	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.00246	ng/wipe	1	U	U	Yes	S2AVE
2,3,4,6,7,8-Hexachlorodibenzofuran	0.00137	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8,9-Hexachlorodibenzofuran	0.00188	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00998	ng/wipe	1	J	J	Yes	S2AVE
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0.00432	ng/wipe	1	J	U	Yes	S2AVE
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.00352	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	0.191	ng/wipe	1	B	U	Yes	S2AVE
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	0.00422	ng/wipe	1	J	U	Yes	S2AVE
Total Tetrachlorodibenzo-p-dioxin	0.00118	ng/wipe	1	U	U	Yes	S2AVE

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
Total Pentachlorodibenzo-p-dioxin	0.00134	ng/wipe	1	U	U	Yes	S2AVE
Total Hexachlorodibenzo-p-dioxin	0.00246	ng/wipe	1	J	J	Yes	S2AVE
Total Heptachlorodibenzo-p-dioxin	0.0521	ng/wipe	1	B		Yes	S2AVE
Total Tetrachlorodibenzofuran	0.0014	ng/wipe	1	J	J	Yes	S2AVE
Total Pentachlorodibenzofuran	0.00276	ng/wipe	1	J	J	Yes	S2AVE
Total Hexachlorodibenzofuran	0.0128	ng/wipe	1	J	J	Yes	S2AVE
Total Heptachlorodibenzofuran	0.0207	ng/wipe	1	J	J	Yes	S2AVE
TEQ WHO1998 Bird ND=0	0.00154	ng/wipe	1			Yes	S2AVE
TEQ WHO1998 Fish ND=0	0.000213	ng/wipe	1			Yes	S2AVE
Total TEQ ND=0	0.00053	ng/wipe	1			Yes	S2AVE

Case No: 41826	Contract: EP10W001070	SDG No: RS003-FB-021312	Lab Code: CAPE
Sample Number: RV001-FW001-001	Method: Dioxin	Matrix: Soil	MA Number: 2196.0
Sample Location:	pH:	Sample Date: 02132012	Sample Time: 09:45:00
% Moisture :		% Solids : 100	

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
2,3,7,8-Tetrachlorodibenzo-p-dioxin	0.0035	ng/wipe	1	U	U	Yes	S2AVE
2,3,7,8-Tetrachlorodibenzofuran	0.00352	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8-Pentachlorodibenzofuran	0.0027	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	0.00712	ng/wipe	1	U	U	Yes	S2AVE
2,3,4,7,8-Pentachlorodibenzofuran	0.00272	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,7,8-Hexachlorodibenzofuran	0.0142	ng/wipe	1	U	R	Yes	S2AVE
1,2,3,6,7,8-Hexachlorodibenzofuran	0.00424	ng/wipe	1	J	J	Yes	S2AVE
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.006	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.007	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.00676	ng/wipe	1	U	U	Yes	S2AVE
2,3,4,6,7,8-Hexachlorodibenzofuran	0.00324	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8,9-Hexachlorodibenzofuran	0.00574	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.0239	ng/wipe	1	J	J	Yes	S2AVE
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0.0625	ng/wipe	1		U	Yes	S2AVE
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.00714	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	0.502	ng/wipe	1	B	U	Yes	S2AVE
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	0.0122	ng/wipe	1	J	U	Yes	S2AVE
Total Tetrachlorodibenzo-p-dioxin	0.0035	ng/wipe	1	U	U	Yes	S2AVE

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
Total Pentachlorodibenzo-p-dioxin	0.00712	ng/wipe	1	U	U	Yes	S2AVE
Total Hexachlorodibenzo-p-dioxin	0.0292	ng/wipe	1	J	J	Yes	S2AVE
Total Heptachlorodibenzo-p-dioxin	0.111	ng/wipe	1	B		Yes	S2AVE
Total Tetrachlorodibenzofuran	0.0417	ng/wipe	1			Yes	S2AVE
Total Pentachlorodibenzofuran	0.070	ng/wipe	1			Yes	S2AVE
Total Hexachlorodibenzofuran	0.0998	ng/wipe	1			Yes	S2AVE
Total Heptachlorodibenzofuran	0.0483	ng/wipe	1	J	J	Yes	S2AVE
TEQ WHO1998 Bird ND=0	0.000778	ng/wipe	1			Yes	S2AVE
TEQ WHO1998 Fish ND=0	0.000778	ng/wipe	1			Yes	S2AVE
Total TEQ ND=0	0.00145	ng/wipe	1			Yes	S2AVE

Case No: 41826	Contract: EP10W001070	SDG No: RS003-FB-021312	Lab Code: CAPE
Sample Number: RV001-FW002-001	Method: Dioxin	Matrix: Soil	MA Number: 2196.0
Sample Location:	pH:	Sample Date: 02132012	Sample Time: 09:55:00
% Moisture :		% Solids : 100	

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
2,3,7,8-Tetrachlorodibenzo-p-dioxin	0.00171	ng/wipe	1	U	U	Yes	S2AVE
2,3,7,8-Tetrachlorodibenzofuran	0.00434	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8-Pentachlorodibenzofuran	0.00618	ng/wipe	1	J	J	Yes	S2AVE
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	0.00494	ng/wipe	1	J	J	Yes	S2AVE
2,3,4,7,8-Pentachlorodibenzofuran	0.00256	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,7,8-Hexachlorodibenzofuran	0.00292	ng/wipe	1	U	R	Yes	S2AVE
1,2,3,6,7,8-Hexachlorodibenzofuran	0.003	ng/wipe	1	J	J	Yes	S2AVE
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.00344	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.00342	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.00356	ng/wipe	1	U	U	Yes	S2AVE
2,3,4,6,7,8-Hexachlorodibenzofuran	0.0027	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8,9-Hexachlorodibenzofuran	0.00398	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.0391	ng/wipe	1	J	J	Yes	S2AVE
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0.0035	ng/wipe	1	J	U	Yes	S2AVE
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.00378	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	0.733	ng/wipe	1			Yes	S2AVE
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	0.00974	ng/wipe	1	J	U	Yes	S2AVE
Total Tetrachlorodibenzo-p-dioxin	0.00928	ng/wipe	1	J	J	Yes	S2AVE

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
Total Pentachlorodibenzo-p-dioxin	0.0293	ng/wipe	1	J	J	Yes	S2AVE
Total Hexachlorodibenzo-p-dioxin	0.00342	ng/wipe	1	U	U	Yes	S2AVE
Total Heptachlorodibenzo-p-dioxin	0.0945	ng/wipe	1	B		Yes	S2AVE
Total Tetrachlorodibenzofuran	0.240	ng/wipe	1			Yes	S2AVE
Total Pentachlorodibenzofuran	0.131	ng/wipe	1			Yes	S2AVE
Total Hexachlorodibenzofuran	0.0488	ng/wipe	1	J	J	Yes	S2AVE
Total Heptachlorodibenzofuran	0.0604	ng/wipe	1			Yes	S2AVE
TEQ WHO1998 Bird ND=0	0.00638	ng/wipe	1			Yes	S2AVE
TEQ WHO1998 Fish ND=0	0.00607	ng/wipe	1			Yes	S2AVE
Total TEQ ND=0	0.00654	ng/wipe	1			Yes	S2AVE

Case No:	41826	Contract:	EP10W001070	SDG No:	RS003-FB-021312	Lab Code:	CAPE
Sample Number:	RV001-LB-021312	Method:	Dioxin	Matrix:	Soil	MA Number:	2196.0
Sample Location:		pH:		Sample Date:	02132012	Sample Time:	09:57:00
% Moisture :				% Solids :	100		

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
2,3,7,8-Tetrachlorodibenzo-p-dioxin	0.00109	ng/wipe	1	U	U	Yes	S2AVE
2,3,7,8-Tetrachlorodibenzofuran	0.00188	ng/wipe	1	J	J	Yes	S2AVE
1,2,3,7,8-Pentachlorodibenzofuran	0.000932	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	0.00212	ng/wipe	1	U	U	Yes	S2AVE
2,3,4,7,8-Pentachlorodibenzofuran	0.000934	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,7,8-Hexachlorodibenzofuran	0.000894	ng/wipe	1	U	R	Yes	S2AVE
1,2,3,6,7,8-Hexachlorodibenzofuran	0.000846	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.00183	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.00188	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.00193	ng/wipe	1	U	U	Yes	S2AVE
2,3,4,6,7,8-Hexachlorodibenzofuran	0.000938	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,7,8,9-Hexachlorodibenzofuran	0.00131	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00108	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0.00384	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.00166	ng/wipe	1	U	U	Yes	S2AVE
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	0.00436	ng/wipe	1	BJ	U	Yes	S2AVE
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	0.00254	ng/wipe	1	U	U	Yes	S2AVE
Total Tetrachlorodibenzo-p-dioxin	0.00109	ng/wipe	1	U	U	Yes	S2AVE

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
Total Pentachlorodibenzo-p-dioxin	0.00212	ng/wipe	1	U	U	Yes	S2AVE
Total Hexachlorodibenzo-p-dioxin	0.00183	ng/wipe	1	U	U	Yes	S2AVE
Total Heptachlorodibenzo-p-dioxin	0.00384	ng/wipe	1	U	U	Yes	S2AVE
Total Tetrachlorodibenzofuran	0.00464	ng/wipe	1	J	J	Yes	S2AVE
Total Pentachlorodibenzofuran	0.000584	ng/wipe	1	U	U	Yes	S2AVE
Total Hexachlorodibenzofuran	0.000846	ng/wipe	1	U	U	Yes	S2AVE
Total Heptachlorodibenzofuran	0.00108	ng/wipe	1	U	U	Yes	S2AVE
TEQ WHO1998 Bird ND=0	0.00188	ng/wipe	1			Yes	S2AVE
TEQ WHO1998 Fish ND=0	0.000095	ng/wipe	1			Yes	S2AVE
Total TEQ ND=0	0.000191	ng/wipe	1			Yes	S2AVE

1DFA - Form 1-HR CDD-1
CDD/CDF Sample Data Summary
High Resolution

EPA Sample No.
RV001-FW001-001
R9NN7

Lab Name: Cape Fear Analytical, LLC (CFA) Contract: EP10W001070
Lab Code: NC001894 Case No. 41826 TO No.: 2196.0 SDG No.: RS003-FB-021312

Matrix: Wipe Lab Sample ID: 3253009
Sample wt/vol: 1 wipe Lab File ID: A23FEB12A-13
Water Sample Prep: N/A Date Received: 14-FEB-12
Concentrated Extract Volume: 20 uL Date Extracted: 21-FEB-12
Injection Volume: 1 uL % Solids/Lipids: 100 Date Analyzed: 23-FEB-12
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um Dilution Factor: 1
Concentration Units: ng/wipe

Target Analyte	Selected Ions	Peak RT	Ion Ratio #	Concentration	Q	EMPC/EDL
2,3,7,8-TCDD	320/322				U	0.0035
1,2,3,7,8-PeCDD	356/358				U	0.00712
1,2,3,4,7,8-HxCDD	390/392				U	0.006
1,2,3,6,7,8-HxCDD	390/392				U	0.007
1,2,3,7,8,9-HxCDD	390/392				U	0.00676
1,2,3,4,6,7,8-HpCDD	424/426	40.4	1.08	~~0.0625~~		.062
1,2,3,4,6,7,8,9-OCDD	458/460	44.69	.92	~~0.502~~	B	.502
2,3,7,8-TCDF	304/306				U	0.00352
1,2,3,7,8-PeCDF	340/342				U	0.0027
2,3,4,7,8-PeCDF	340/342				U	0.00272
1,2,3,4,7,8-HxCDF	374/376				U R	0.0142
1,2,3,6,7,8-HxCDF	374/376	36.32	1.12	0.00424	J	
1,2,3,7,8,9-HxCDF	374/376				U	0.00574
2,3,4,6,7,8-HxCDF	374/376				U	0.00324
1,2,3,4,6,7,8-HpCDF	408/410	39.1	1.05	0.0239	J	
1,2,3,4,7,8,9-HpCDF	408/410				U	0.00714
1,2,3,4,6,7,8,9-OCDF	442/444	44.99	.97	0.0191	J	

NOTE: Concentrations, Estimated Maximum Possible Concentrations (EMPCs), and Estimated Detection Levels (EDLs) for solid samples are calculated on a dry weight basis (except tissues, which are reported on a wet weight basis with % Lipids).

Labeled Compounds	Selected Ions	Peak RT	Ion Ratio #	Ion Ratio Limits	% Rec #	Recovery Limits
13C-2,3,7,8-TCDD	332/334	31.52	.78	0.65-0.89	77.5	(25%-164%)
13C-1,2,3,7,8-PeCDD	368/370	34.32	1.55	1.32-1.78	75.6	(25%-181%)
13C-1,2,3,4,7,8-HxCDD	402/404	36.94	1.27	1.05-1.43	86.4	(32%-141%)
13C-1,2,3,6,7,8-HxCDD	402/404	37.03	1.25	1.05-1.43	78.8	(28%-130%)
13C-1,2,3,4,6,7,8-HpCDD	436/438	40.38	1.03	0.88-1.20	82.9	(23%-140%)
13C-OCDD	470/472	44.68	.91	0.76-1.02	80.3	(17%-157%)
13C-2,3,7,8-TCDF	316/318	30.93	.79	0.65-0.89	84.0	(24%-169%)
13C-1,2,3,7,8-PeCDF	352/354	33.52	1.58	1.32-1.78	63.8	(24%-185%)
13C-2,3,4,7,8-PeCDF	352/354	34.14	1.58	1.32-1.78	72.9	(21%-178%)
13C-1,2,3,4,7,8-HxCDF	384/386	36.22	.53	0.43-0.59	19.6	(26%-152%)
13C-1,2,3,6,7,8-HxCDF	384/386	36.33	.5	0.43-0.59	77.8	(26%-123%)
13C-2,3,4,6,7,8-HxCDF	384/386	36.82	.52	0.43-0.59	77.2	(28%-136%)
13C-1,2,3,7,8,9-HxCDF	384/386	37.6	.51	0.43-0.59	55.5	(29%-147%)
13C-1,2,3,4,6,7,8-HpCDF	418/420	39.1	.44	0.37-0.51	81.1	(28%-143%)
13C-1,2,3,4,7,8,9-HpCDF	418/420	41.07	.43	0.37-0.51	81.2	(26%-138%)
37Cl-2,3,7,8-TCDD	328/NA	31.53	NA	NA	90.4	(35%-197%)

Column to be used to flag values outside QC limits.

1DFA - Form 1-HR CDD-1
CDD/CDF Sample Data Summary
High Resolution

EPA Sample No.
RV001-FW002-001
B4NN8

Lab Name: Cape Fear Analytical, LLC (CFA) Contract: EP10W001070
Lab Code: NC001894 Case No. 41826 TO No.: 2196.0 SDG No.: RS003-FB-021312

Matrix: Wipe Lab Sample ID: 3253010
Sample wt/vol: 1 wipe Lab File ID: A24FEB12A_3-4
Water Sample Prep: N/A Date Received: 14-FEB-12
Concentrated Extract Volume: 20 uL Date Extracted: 21-FEB-12
Injection Volume: 1 uL % Solids/Lipids: 100 Date Analyzed: 25-FEB-12
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um Dilution Factor: 1
Concentration Units: ng/wipe

Target Analyte	Selected Ions	Peak RT	Ion Ratio #	Concentration	Q	EMPC/EDL
2,3,7,8-TCDD	320/322				U	0.00171
1,2,3,7,8-PeCDD	356/358	34.39	1.54	0.00494	J	
1,2,3,4,7,8-HxCDD	390/392				U	0.00344
1,2,3,6,7,8-HxCDD	390/392				U	0.00342
1,2,3,7,8,9-HxCDD	390/392				U	0.00356
1,2,3,4,6,7,8-HpCDD	424/426	40.42	1.06	~~0.0487~~	J	0.0487
1,2,3,4,6,7,8,9-OCDD	458/460	44.72	.89	~~0.733~~		0.723
2,3,7,8-TCDF	304/306				U	0.00434
1,2,3,7,8-PeCDF	340/342	33.5	1.78	0.00618	J	
2,3,4,7,8-PeCDF	340/342				U	0.00256
1,2,3,4,7,8-HxCDF	374/376				U	0.00292
1,2,3,6,7,8-HxCDF	374/376	36.31	1.09	0.003	J	
1,2,3,7,8,9-HxCDF	374/376				U	0.00398
2,3,4,6,7,8-HxCDF	374/376				U	0.0027
1,2,3,4,6,7,8-HpCDF	408/410	39.12	.97	0.0391	J	
1,2,3,4,7,8,9-HpCDF	408/410				U	0.00378
1,2,3,4,6,7,8,9-OCDF	442/444	45.03	.91	0.0655	J	

NOTE: Concentrations, Estimated Maximum Possible Concentrations (EMPCs), and Estimated Detection Levels (EDLs) for solid samples are calculated on a dry weight basis (except tissues, which are reported on a wet weight basis with % Lipids).

Labeled Compounds	Selected Ions	Peak RT	Ion Ratio #	Ion Ratio Limits	% Rec #	Recovery Limits
13C-2,3,7,8-TCDD	332/334	31.55	.78	0.65-0.89	83.0	(25%-164%)
13C-1,2,3,7,8-PeCDD	368/370	34.34	1.6	1.32-1.78	69.6	(25%-181%)
13C-1,2,3,4,7,8-HxCDD	402/404	36.96	1.25	1.05-1.43	84.8	(32%-141%)
13C-1,2,3,6,7,8-HxCDD	402/404	37.04	1.26	1.05-1.43	82.5	(28%-130%)
13C-1,2,3,4,6,7,8-HpCDD	436/438	40.4	1.03	0.88-1.20	88.2	(23%-140%)
13C-OCDD	470/472	44.71	.9	0.76-1.02	90.3	(17%-157%)
13C-2,3,7,8-TCDF	316/318	30.96	.78	0.65-0.89	82.5	(24%-169%)
13C-1,2,3,7,8-PeCDF	352/354	33.53	1.6	1.32-1.78	65.7	(24%-185%)
13C-2,3,4,7,8-PeCDF	352/354	34.14	1.47	1.32-1.78	21.6	(21%-178%)
13C-1,2,3,4,7,8-HxCDF	384/386	36.24	.51	0.43-0.59	72.3	(26%-152%)
13C-1,2,3,6,7,8-HxCDF	384/386	36.34	.51	0.43-0.59	82.3	(26%-123%)
13C-2,3,4,6,7,8-HxCDF	384/386	36.83	.52	0.43-0.59	78.8	(28%-136%)
13C-1,2,3,7,8,9-HxCDF	384/386	37.62	.52	0.43-0.59	70.3	(29%-147%)
13C-1,2,3,4,6,7,8-HpCDF	418/420	39.12	.44	0.37-0.51	90.0	(28%-143%)
13C-1,2,3,4,7,8,9-HpCDF	418/420	41.1	.45	0.37-0.51	90.1	(26%-138%)
37Cl-2,3,7,8-TCDD	328/NA	31.56	NA	NA	91.4	(35%-197%)

Column to be used to flag values outside QC limits.

1DFA - Form I-HR CDD-1
CDD/CDF Sample Data Summary
High Resolution

EPA Sample No. FB
RV001-FB-021312
B9NN9

Lab Name: Cape Fear Analytical, LLC (CFA) Contract: EP10W001070
Lab Code: NC001894 Case No. 41826 TO No.: 2196.0 SDG No.: RS003-FB-021312

Matrix: Wipe Lab Sample ID: 3253011
Sample wt/vol: 1 wipe Lab File ID: A24FEB12A_3-5
Water Sample Prep: N/A Date Received: 14-FEB-12
Concentrated Extract Volume: 20 uL Date Extracted: 21-FEB-12
Injection Volume: 1 uL % Solids/Lipids: 100 Date Analyzed: 25-FEB-12
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um Dilution Factor: 1
Concentration Units: ng/wipe

Target Analyte	Selected Ions	Peak RT	Ion Ratio #	Concentration	Q	EMPC/EDL
2,3,7,8-TCDD	320/322				U	0.00118
1,2,3,7,8-PeCDD	356/358				U	0.00134
1,2,3,4,7,8-HxCDD	390/392				U	0.00236
1,2,3,6,7,8-HxCDD	390/392				U	0.00238
1,2,3,7,8,9-HxCDD	390/392				U	0.00246
1,2,3,4,6,7,8-HpCDD	424/426	40.33	1.14	0.0228	J	
1,2,3,4,6,7,8,9-OCDD	458/460	44.64	.85	0.191	B	
2,3,7,8-TCDF	304/306	30.89	.79	0.0014	J	
1,2,3,7,8-PeCDF	340/342				U	0.00109
2,3,4,7,8-PeCDF	340/342				U	0.00104
1,2,3,4,7,8-HxCDF	374/376				U	0.00131
1,2,3,6,7,8-HxCDF	374/376				U	0.00127
1,2,3,7,8,9-HxCDF	374/376				U	0.00188
2,3,4,6,7,8-HxCDF	374/376				U	0.00137
1,2,3,4,6,7,8-HpCDF	408/410	39.05	.88	0.00998	J	
1,2,3,4,7,8,9-HpCDF	408/410				U	0.00352
1,2,3,4,6,7,8,9-OCDF	442/444	44.97	.97	0.0149	J	

NOTE: Concentrations, Estimated Maximum Possible Concentrations (EMPCs), and Estimated Detection Levels (EDLs) for solid samples are calculated on a dry weight basis (except tissues, which are reported on a wet weight basis with % Lipids).

Labeled Compounds	Selected Ions	Peak RT	Ion Ratio #	Ion Ratio Limits	% Rec #	Recovery Limits
13C-2,3,7,8-TCDD	332/334	31.51	.78	0.65-0.89	72.4	(25%-164%)
13C-1,2,3,7,8-PeCDD	368/370	34.3	1.57	1.32-1.78	74.6	(25%-181%)
13C-1,2,3,4,7,8-HxCDD	402/404	36.91	1.28	1.05-1.43	79.8	(32%-141%)
13C-1,2,3,6,7,8-HxCDD	402/404	37	1.27	1.05-1.43	82.3	(28%-130%)
13C-1,2,3,4,6,7,8-HpCDD	436/438	40.33	1.05	0.88-1.20	77.7	(23%-140%)
13C-OCDD	470/472	44.62	.89	0.76-1.02	76.8	(17%-157%)
13C-2,3,7,8-TCDF	316/318	30.91	.78	0.65-0.89	68.6	(24%-169%)
13C-1,2,3,7,8-PeCDF	352/354	33.51	1.53	1.32-1.78	71.9	(24%-185%)
13C-2,3,4,7,8-PeCDF	352/354	34.12	1.59	1.32-1.78	71.7	(21%-178%)
13C-1,2,3,4,7,8-HxCDF	384/386	36.19	.53	0.43-0.59	79.6	(26%-152%)
13C-1,2,3,6,7,8-HxCDF	384/386	36.29	.51	0.43-0.59	79.0	(26%-123%)
13C-2,3,4,6,7,8-HxCDF	384/386	36.79	.52	0.43-0.59	73.9	(28%-136%)
13C-1,2,3,7,8,9-HxCDF	384/386	37.58	.51	0.43-0.59	76.4	(29%-147%)
13C-1,2,3,4,6,7,8-HpCDF	418/420	39.06	.44	0.37-0.51	76.9	(28%-143%)
13C-1,2,3,4,7,8,9-HpCDF	418/420	41.02	.45	0.37-0.51	73.5	(26%-138%)
37Cl-2,3,7,8-TCDD	328/NA	31.52	NA	NA	91.6	(35%-197%)

Column to be used to flag values outside QC limits.

1DFA - Form 1-HR CDD-1
CDD/CDF Sample Data Summary
High Resolution

EPA Sample No.
RV001-LB-021312
BG NPO

Lab Name: Cape Fear Analytical, LLC (CFA) Contract: EP10W001070
Lab Code: NC001894 Case No. 41826 TO No.: 2196.0 SDG No.: RS003-FB-021312

Matrix: Wipe Lab Sample ID: 3253012
Sample wt/vol: 1 wipe Lab File ID: A24FEB12A_3-6
Water Sample Prep: N/A Date Received: 14-FEB-12
Concentrated Extract Volume: 20 ul Date Extracted: 21-FEB-12
Injection Volume: 1 ul % Solids/Lipids: 100 Date Analyzed: 25-FEB-12
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um Dilution Factor: 1
Concentration Units: ng/wipe

Target Analyte	Selected Ions	Peak RT	Ion Ratio #	Concentration	Q	EMPC/EDL
2,3,7,8-TCDD	320/322				U	0.00109
1,2,3,7,8-PeCDD	356/358				U	0.00212
1,2,3,4,7,8-HxCDD	390/392				U	0.00183
1,2,3,6,7,8-HxCDD	390/392				U	0.00188
1,2,3,7,8,9-HxCDD	390/392				U	0.00193
1,2,3,4,6,7,8-HpCDD	424/426				U	0.00384
1,2,3,4,6,7,8,9-OCDD	458/460	44.69	.99	0.0103	BJ	
2,3,7,8-TCDF	304/306	30.94	.68	0.00188	J	
1,2,3,7,8-PeCDF	340/342				U	0.000932
2,3,4,7,8-PeCDF	340/342				U	0.000934
1,2,3,4,7,8-HxCDF	374/376				U	0.000894
1,2,3,6,7,8-HxCDF	374/376				U	0.000846
1,2,3,7,8,9-HxCDF	374/376				U	0.00131
2,3,4,6,7,8-HxCDF	374/376				U	0.000938
1,2,3,4,6,7,8-HpCDF	408/410				U	0.00108
1,2,3,4,7,8,9-HpCDF	408/410				U	0.00166
1,2,3,4,6,7,8,9-OCDF	442/444				U	0.00254

NOTE: Concentrations, Estimated Maximum Possible Concentrations (EMPCs), and Estimated Detection Levels (EDLs) for solid samples are calculated on a dry weight basis (except tissues, which are reported on a wet weight basis with % Lipids).

Labeled Compounds	Selected Ions	Peak RT	Ion Ratio #	Ion Ratio Limits	% Rec #	Recovery Limits
13C-2,3,7,8-TCDD	332/334	31.51	.78	0.65-0.89	80.7	(25%-164%)
13C-1,2,3,7,8-PeCDD	368/370	34.3	1.6	1.32-1.78	83.6	(25%-181%)
13C-1,2,3,4,7,8-HxCDD	402/404	36.91	1.26	1.05-1.43	88.2	(32%-141%)
13C-1,2,3,6,7,8-HxCDD	402/404	36.99	1.27	1.05-1.43	86.8	(28%-130%)
13C-1,2,3,4,6,7,8-HpCDD	436/438	40.32	1.05	0.88-1.20	83.7	(23%-140%)
13C-OCDD	470/472	44.62	.91	0.76-1.02	82.8	(17%-157%)
13C-2,3,7,8-TCDF	316/318	30.91	.78	0.65-0.89	74.7	(24%-169%)
13C-1,2,3,7,8-PeCDF	352/354	33.5	1.58	1.32-1.78	78.9	(24%-185%)
13C-2,3,4,7,8-PeCDF	352/354	34.12	1.57	1.32-1.78	79.5	(21%-178%)
13C-1,2,3,4,7,8-HxCDF	384/386	36.19	.52	0.43-0.59	83.4	(26%-152%)
13C-1,2,3,6,7,8-HxCDF	384/386	36.29	.52	0.43-0.59	83.6	(26%-123%)
13C-2,3,4,6,7,8-HxCDF	384/386	36.78	.51	0.43-0.59	79.8	(28%-136%)
13C-1,2,3,7,8,9-HxCDF	384/386	37.57	.52	0.43-0.59	79.4	(29%-147%)
13C-1,2,3,4,6,7,8-HpCDF	418/420	39.05	.45	0.37-0.51	82.6	(28%-143%)
13C-1,2,3,4,7,8,9-HpCDF	418/420	41.01	.44	0.37-0.51	81.4	(26%-138%)
37Cl-2,3,7,8-TCDD	328/NA	31.52	NA	NA	91.9	(35%-197%)

Column to be used to flag values outside QC limits.

1DFB - Form I-HR CDD-2
CDD/CDF Toxicity Equivalence Summary
High Resolution

EPA Sample No.
RV001-FW001-001
B9NN7

Lab Name: Cape Fear Analytical, LLC (CFA)
Lab Code: NC001894 Case No.: 41826
Matrix: Wipe
Sample wt/vol: 1 wipe
Water Sample Prep: N/A
Concentrated Extract Volume: 20 uL
Injection Volume: 1 uL % Solids/Lipids: 100
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um
Concentration Units: ng/wipe

Contract: EP10W001070
TO No.: 2196.0 SDG No.: RS003-FB-021312
Lab Sample ID: 3253009
Lab File ID: A23FEB12A-13
Date Received: 14-FEB-12
Date Extracted: 21-FEB-12
Date Analyzed: 23-FEB-12
Dilution Factor: 1

Target Analyte	Concentration	TEF*	TEF-Adjusted Concentration
2,3,7,8-TCDD	0	x 1 =	0
1,2,3,7,8-PeCDD	0	x 1 =	0
1,2,3,4,7,8-HxCDD	0	x 0.1 =	0
1,2,3,6,7,8-HxCDD	0	x 0.1 =	0
1,2,3,7,8,9-HxCDD	0	x 0.1 =	0
1,2,3,4,6,7,8-HpCDD	0 ~~.0625~~	~~x 0.01 =~~	~~.000625~~ 0
1,2,3,4,6,7,8,9-OCDD	0 .502	~~x 0.0003 =~~	.0001506 0
2,3,7,8-TCDF	0	x 0.1 =	0
1,2,3,7,8-PeCDF	0	x 0.03 =	0
2,3,4,7,8-PeCDF	0	x 0.3 =	0
1,2,3,4,7,8-HxCDF	0	x 0.1 =	0
1,2,3,6,7,8-HxCDF	.00424	x 0.1 =	.000424
1,2,3,7,8,9-HxCDF	0	x 0.1 =	0
2,3,4,6,7,8-HxCDF	0	x 0.1 =	0
1,2,3,4,6,7,8-HpCDF	.0239	x 0.01 =	.000239
1,2,3,4,7,8,9-HpCDF	0	x 0.01 =	0
1,2,3,4,6,7,8,9-OCDF	.0191	x 0.0003 =	.00000573
		Total =	~~.0144433~~ .0066873

* TEF - Toxicity Equivalent Factors from the World Health Organization (WHO), 2005.

1DFB - Form 1-HR CDD-2
CDD/CDF Toxicity Equivalence Summary
High Resolution

EPA Sample No
RV001-FW002-001
B9NN8

Lab Name: Cape Fear Analytical, LLC (CFA)
Lab Code: NC001894 Case No.: 41826
Matrix: Wipe
Sample wt/vol: 1 wipe
Water Sample Prep: N/A
Concentrated Extract Volume: 20 uL
Injection Volume: 1 uL % Solids/Lipids: 100
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um
Concentration Units: ng/wipe

Contract: EP10W001070
TO No.: 2196.0 SDG No.: RS003-FB-021312
Lab Sample ID: 3253010
Lab File ID: A24FEB12A_3-4
Date Received: 14-FEB-12
Date Extracted: 21-FEB-12
Date Analyzed: 25-FEB-12
Dilution Factor: 1

Target Analyte	Concentration	TEF*	TEF-Adjusted Concentration
2,3,7,8-TCDD	0	x 1 =	0
1,2,3,7,8-PeCDD	.00494	x 1 =	.00494
1,2,3,4,7,8-HxCDD	0	x 0.1 =	0
1,2,3,6,7,8-HxCDD	0	x 0.1 =	0
1,2,3,7,8,9-HxCDD	0	x 0.1 =	0
1,2,3,4,6,7,8-HpCDD	0 ~~.0487~~	x 0.01 =	~~.000487~~ 0
1,2,3,4,6,7,8,9-OCDD	0 ~~.733~~	x 0.0003 =	.0002199 0
2,3,7,8-TCDF	0	x 0.1 =	0
1,2,3,7,8-PeCDF	.00618	x 0.03 =	.0001854
2,3,4,7,8-PeCDF	0	x 0.3 =	0
1,2,3,4,7,8-HxCDF	0	x 0.1 =	0
1,2,3,6,7,8-HxCDF	.003	x 0.1 =	.0003
1,2,3,7,8,9-HxCDF	0	x 0.1 =	0
2,3,4,6,7,8-HxCDF	0	x 0.1 =	0
1,2,3,4,6,7,8-HpCDF	.0391	x 0.01 =	.000391
1,2,3,4,7,8,9-HpCDF	0	x 0.01 =	0
1,2,3,4,6,7,8,9-OCDF	.0655	x 0.0003 =	.00001965
		Total =	~~.00654295~~ .00583605

* TEF - Toxicity Equivalent Factors from the World Health Organization (WHO), 2005.

FB

1DFB - Form I-HR CDD-2
CDD/CDF Toxicity Equivalence Summary
High Resolution

EPA Sample No.
RV001-FB-021312
R9NN9

Lab Name: Cape Fear Analytical, LLC (CFA)
Lab Code: NC001894 Case No.: 41826
Matrix: Wipe
Sample wt/vol: 1 wipe
Water Sample Prep: N/A
Concentrated Extract Volume: 20 uL
Injection Volume: 1 uL % Solids/Lipids: 100
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um
Concentration Units: ng/wipe

Contract: EP10W001070
TO No.: 2196.0 SDG No.: RS003-FB-021312
Lab Sample ID: 3253011
Lab File ID: A24FEB12A_3-5
Date Received: 14-FEB-12
Date Extracted: 21-FEB-12
Date Analyzed: 25-FEB-12
Dilution Factor: 1

Target Analyte	Concentration	TEF*	TEF-Adjusted Concentration
2,3,7,8-TCDD	0	x 1 =	0
1,2,3,7,8-PeCDD	0	x 1 =	0
1,2,3,4,7,8-HxCDD	0	x 0.1 =	0
1,2,3,6,7,8-HxCDD	0	x 0.1 =	0
1,2,3,7,8,9-HxCDD	0	x 0.1 =	0
1,2,3,4,6,7,8-HpCDD	.0228	x 0.01 =	.000228
1,2,3,4,6,7,8,9-OCDD	.191	x 0.0003 =	.0000573
2,3,7,8-TCDF	.0014	x 0.1 =	.00014
1,2,3,7,8-PeCDF	0	x 0.03 =	0
2,3,4,7,8-PeCDF	0	x 0.3 =	0
1,2,3,4,7,8-HxCDF	0	x 0.1 =	0
1,2,3,6,7,8-HxCDF	0	x 0.1 =	0
1,2,3,7,8,9-HxCDF	0	x 0.1 =	0
2,3,4,6,7,8-HxCDF	0	x 0.1 =	0
1,2,3,4,6,7,8-HpCDF	.00998	x 0.01 =	.0000998
1,2,3,4,7,8,9-HpCDF	0	x 0.01 =	0
1,2,3,4,6,7,8,9-OCDF	.0149	x 0.0003 =	.00000447
		Total =	.00052957

* TEF - Toxicity Equivalent Factors from the World Health Organization (WHO), 2005.

Lot B
Blk

1DFB - Form I-HR CDD-2
CDD/CDF Toxicity Equivalence Summary
High Resolution

EPA Sample No.
RV001-LB-021312
B9NP0

Lab Name: Cape Fear Analytical, LLC (CFA) Contract: EP10W001070
Lab Code: NC001894 Case No.: 41826 TO No.: 2196.0 SDG No.: RS003-FB-021312
Matrix: Wipe Lab Sample ID: 3253012
Sample wt/vol: 1 wipe Lab File ID: A24FEB12A_3-6
Water Sample Prep: N/A Date Received: 14-FEB-12
Concentrated Extract Volume: 20 uL Date Extracted: 21-FEB-12
Injection Volume: 1 uL % Solids/Lipids: 100 Date Analyzed: 25-FEB-12
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um Dilution Factor: 1
Concentration Units: ng/wipe

Target Analyte	Concentration	TEF*	TEF-Adjusted Concentration
2,3,7,8-TCDD	0	x 1 =	0
1,2,3,7,8-PeCDD	0	x 1 =	0
1,2,3,4,7,8-HxCDD	0	x 0.1 =	0
1,2,3,6,7,8-HxCDD	0	x 0.1 =	0
1,2,3,7,8,9-HxCDD	0	x 0.1 =	0
1,2,3,4,6,7,8-HpCDD	0	x 0.01 =	0
1,2,3,4,6,7,8,9-OCDD	.0103	x 0.0003 =	.00000309
2,3,7,8-TCDF	.00188	x 0.1 =	.000188
1,2,3,7,8-PeCDF	0	x 0.03 =	0
2,3,4,7,8-PeCDF	0	x 0.3 =	0
1,2,3,4,7,8-HxCDF	0	x 0.1 =	0
1,2,3,6,7,8-HxCDF	0	x 0.1 =	0
1,2,3,7,8,9-HxCDF	0	x 0.1 =	0
2,3,4,6,7,8-HxCDF	0	x 0.1 =	0
1,2,3,4,6,7,8-HpCDF	0	x 0.01 =	0
1,2,3,4,7,8,9-HpCDF	0	x 0.01 =	0
1,2,3,4,6,7,8,9-OCDF	0	x 0.0003 =	0
		Total =	.00019109

* TEF - Toxicity Equivalent Factors from the World Health Organization (WHO), 2005.

1DFD - Form I-HR CDD-4
TEF Adjusted Concentration Mammal/Fish/Bird

EPA Sample No.
RV001-FW001-001
B4NN4

Lab Name: Cape Fear Analytical, LLC (CFA) Contract: EP10W001070
Lab Code: NC001894 Case No.: 41826 TO No.: 2196.0 SDG No.: RS003-FB-021312
Matrix: Wipe Lab Sample ID: 3253009
Sample wt/vol: 1 wipe Lab File ID: A23FEB12A-13
Water Sample Prep: N/A Date Received: 14-FEB-12
Concentrated Extract Volume: 20 uL Date Extracted: 21-FEB-12
Injection Volume: 1 uL % Solids/Lipids: 100 Date Analyzed: 23-FEB-12
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um Dilution Factor: 1
Concentration Units: ng/wipe

Target Analyte	Conc.	TEF Mammal	TEF-Adj. Conc.	TEF Fish	TEF-Adj. Conc.	TEF Bird	TEF-Adj. Conc.
2,3,7,8-TCDD	.0035	1	.0035	1	.0035	1	.0035
1,2,3,7,8-PeCDD	.00712	1	.00712	1	.00712	1	.00712
1,2,3,4,7,8-HxCDD	.006	0.1	.0006	0.5	003	0.05	.0003
1,2,3,6,7,8-HxCDD	.007	0.1	.0007	0.01	.00007	0.01	.00007
1,2,3,7,8,9-HxCDD	.00676	0.1	.000676	0.01	.0000676	0.1	.000676
1,2,3,4,6,7,8-HpCDD	0.0625	0.01	.000625	0.001	.0000625	0.001	.0000625
1,2,3,4,6,7,8,9-OCDD	0.502	0.0003	.0001506	0.0001	.0000502	0.0001	.0000502
2,3,7,8-TCDF	.00352	0.1	.000352	0.05	.000176	1	.00352
1,2,3,7,8-PeCDF	.0027	0.03	.000081	0.05	.000135	0.1	.00027
2,3,4,7,8-PeCDF	.00272	0.3	.000816	0.5	.00136	1	.00272
1,2,3,4,7,8-HxCDF	.0142	0.1	.00142	0.1	.00142	0.1	.00142
1,2,3,6,7,8-HxCDF	0.00424	0.1	.000424	0.1	.000424	0.1	.000424
1,2,3,7,8,9-HxCDF	.00574	0.1	.000574	0.1	.000574	0.1	.000574
2,3,4,6,7,8-HxCDF	.00324	0.1	.000324	0.1	.000324	0.1	.000324
1,2,3,4,6,7,8-HpCDF	0.0239	0.01	.000239	0.01	.000239	0.01	.000239
1,2,3,4,7,8,9-HpCDF	.00714	0.01	.0000714	0.01	.0000714	0.01	.0000714
1,2,3,4,6,7,8,9-OCDF	0.0191	0.0003	.00000573	0.0001	.00000191	0.0001	.00000191
		Total =	.01767873	Total =	.01859561	Total =	.02134301

TEF - Toxicity Equivalent Factors from the World Health Organization (WHO) (Mammal 2005, Fish and Bird 1998).

DFD - Form 1-HR CDD-4
TEF Adjusted Concentration Mammal/Fish/Bird

EPA Sample No.
RV001-FW002-001
R1MP

Lab Name: Cape Fear Analytical, LLC (CFA) Contract: EP10W001070
Lab Code: NC001894 Case No.: 41826 TO No.: 2196.0 SDG No.: RS003-FB-021312
Matrix: Wipe Lab Sample ID: 3253010
Sample wt/vol: 1 wipe Lab File ID: A24FEB12A_3-4
Water Sample Prep: N/A Date Received: 14-FEB-12
Concentrated Extract Volume: 20 uL Date Extracted: 21-FEB-12
Injection Volume: 1 uL % Solids/Lipids: 100 Date Analyzed: 25-FEB-12
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um Dilution Factor: 1
Concentration Units: ng/wipe

Target Analyte	Conc.	TEF Mammal	TEF-Adj. Conc.	TEF Fish	TEF-Adj. Conc.	TEF Bird	TEF-Adj. Conc.
2,3,7,8-TCDD	.00171	1	.00171	1	.00171	1	.00171
1,2,3,7,8-PeCDD	0.00494	1	.00494	1	.00494	1	.00494
1,2,3,4,7,8-HxCDD	.00344	0.1	.000344	0.5	.00172	0.05	.000172
1,2,3,6,7,8-HxCDD	.00342	0.1	.000342	0.01	.0000342	0.01	.0000342
1,2,3,7,8,9-HxCDD	.00356	0.1	.000356	0.01	.0000356	0.1	.000356
1,2,3,4,6,7,8-HpCDD	0.0487	0.01	.000487	0.001	.0000487	0.001	.0000487
1,2,3,4,6,7,8,9-OCDD	0.733	0.0003	.0002199	0.0001	.0000733	0.0001	.0000733
2,3,7,8-TCDF	.00434	0.1	.000434	0.05	.000217	1	.00434
1,2,3,7,8-PeCDF	0.00618	0.03	.0001854	0.05	.000309	0.1	.000618
2,3,4,7,8-PeCDF	.00256	0.3	.000768	0.5	.00128	1	.00256
1,2,3,4,7,8-HxCDF	.00292	0.1	.000292	0.1	.000292	0.1	.000292
1,2,3,6,7,8-HxCDF	0.003	0.1	.0003	0.1	.0003	0.1	.0003
1,2,3,7,8,9-HxCDF	.00398	0.1	.000398	0.1	.000398	0.1	.000398
2,3,4,6,7,8-HxCDF	.0027	0.1	.00027	0.1	.00027	0.1	.00027
1,2,3,4,6,7,8-HpCDF	0.0391	0.01	.000391	0.01	.000391	0.01	.000391
1,2,3,4,7,8,9-HpCDF	.00378	0.01	.0000378	0.01	.0000378	0.01	.0000378
1,2,3,4,6,7,8,9-OCDF	0.0655	0.0003	.00001965	0.0001	.00000655	0.0001	.00000655
		Total =	.01149475	Total =	.01206315	Total =	.01654755

TEF - Toxicity Equivalent Factors from the World Health Orgnization (WHO) (Mammal 2005, Fish and Bird 1998).

1DFD - Form I-HR CDD-4
TEF Adjusted Concentration Mammal/Fish/Bird

EPA Sample No.
RV001-FB-021312
B1 NVG

Lab Name: Cape Fear Analytical, LLC (CFA) Contract: EP10W001070
Lab Code: NC001894 Case No.: 41826 TO No.: 2196.0 SDG No.: RS003-FB-021312
Matrix: Wipe Lab Sample ID: 3253011
Sample wt/vol: 1 wipe Lab File ID: A24FEB12A_3-5
Water Sample Prep: N/A Date Received: 14-FEB-12
Concentrated Extract Volume: 20 uL Date Extracted: 21-FEB-12
Injection Volume: 1 uL % Solids/Lipids: 100 Date Analyzed: 25-FEB-12
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um Dilution Factor: 1
Concentration Units: ng/wipe

Target Analyte	Conc.	TEF Mammal	TEF-Adj. Conc.	TEF Fish	TEF-Adj. Conc.	TEF Bird	TEF-Adj. Conc.
2,3,7,8-TCDD	.00118	1	.00118	1	.00118	1	.00118
1,2,3,7,8-PeCDD	.00134	1	.00134	1	.00134	1	.00134
1,2,3,4,7,8-HxCDD	.00236	0.1	.000236	0.5	.00118	0.05	.000118
1,2,3,6,7,8-HxCDD	.00238	0.1	.000238	0.01	.0000238	0.01	.0000238
1,2,3,7,8,9-HxCDD	.00246	0.1	.000246	0.01	.0000246	0.1	.000246
1,2,3,4,6,7,8-HpCDD	0.0228	0.01	.000228	0.001	.0000228	0.001	.0000228
1,2,3,4,6,7,8,9-OCDD	0.191	0.0003	.0000573	0.0001	.0000191	0.0001	.0000191
2,3,7,8-TCDF	0.0014	0.1	.00014	0.05	.00007	1	.0014
1,2,3,7,8-PeCDF	.00109	0.03	.0000327	0.05	.0000545	0.1	.000109
2,3,4,7,8-PeCDF	.00104	0.3	.000312	0.5	.00052	1	.00104
1,2,3,4,7,8-HxCDF	.00131	0.1	.000131	0.1	.000131	0.1	.000131
1,2,3,6,7,8-HxCDF	.00127	0.1	.000127	0.1	.000127	0.1	.000127
1,2,3,7,8,9-HxCDF	.00188	0.1	.000188	0.1	.000188	0.1	.000188
2,3,4,6,7,8-HxCDF	.00137	0.1	.000137	0.1	.000137	0.1	.000137
1,2,3,4,6,7,8-HpCDF	0.00998	0.01	.0000998	0.01	.0000998	0.01	.0000998
1,2,3,4,7,8,9-HpCDF	.00352	0.01	.0000352	0.01	.0000352	0.01	.0000352
1,2,3,4,6,7,8,9-OCDF	0.0149	0.0003	.00000447	0.0001	.00000149	0.0001	.00000149
		Total =	.00473247	Total =	.00515429	Total =	.00621819

TEF - Toxicity Equivalent Factors from the World Health Orgnization (WHO) (Mammal 2005, Fish and Bird 1998).

1DFD - Form I-HR CDD-4
TEF Adjusted Concentration Mammal/Fish/Bird

EPA Sample No.
RV001-LB-021312
B4N PC

Lab Name: Cape Fear Analytical, LLC (CFA) Contract: EP10W001070
Lab Code: NC001894 Case No.: 41826 TO No.: 2196.0 SDG No.: RS003-FB-021312
Matrix: Wipe Lab Sample ID: 3253012
Sample wt/vol: 1 wipe Lab File ID: A24FEB12A_3-6
Water Sample Prep: N/A Date Received: 14-FEB-12
Concentrated Extract Volume: 20 uL Date Extracted: 21-FEB-12
Injection Volume: 1 uL % Solids/Lipids: 100 Date Analyzed: 25-FEB-12
GC Column: DB-5MS ID: 60m x 0.25mm, 0.25um Dilution Factor: 1
Concentration Units: ng/wipe

Target Analyte	Conc.	TEF Mammal	TEF-Adj. Conc.	TEF Fish	TEF-Adj. Conc.	TEF Bird	TEF-Adj. Conc.
2,3,7,8-TCDD	.00109	1	.00109	1	.00109	1	.00109
1,2,3,7,8-PeCDD	.00212	1	.00212	1	.00212	1	.00212
1,2,3,4,7,8-HxCDD	.00183	0.1	.000183	0.5	.000915	0.05	.0000915
1,2,3,6,7,8-HxCDD	.00188	0.1	.000188	0.01	.0000188	0.01	.0000188
1,2,3,7,8,9-HxCDD	.00193	0.1	.000193	0.01	.0000193	0.1	.000193
1,2,3,4,6,7,8-HpCDD	.00384	0.01	.0000384	0.001	.00000384	0.001	.00000384
1,2,3,4,6,7,8,9-OCDD	0.0103	0.0003	.00000309	0.0001	.00000103	0.0001	.00000103
2,3,7,8-TCDF	0.00188	0.1	.000188	0.05	.000094	1	.00188
1,2,3,7,8-PeCDF	.000932	0.03	.00002796	0.05	.0000466	0.1	.0000932
2,3,4,7,8-PeCDF	.000934	0.3	.0002802	0.5	.000467	1	.000934
1,2,3,4,7,8-HxCDF	.000894	0.1	.0000894	0.1	.0000894	0.1	.0000894
1,2,3,6,7,8-HxCDF	.000846	0.1	.0000846	0.1	.0000846	0.1	.0000846
1,2,3,7,8,9-HxCDF	.00131	0.1	.000131	0.1	.000131	0.1	.000131
2,3,4,6,7,8-HxCDF	.000938	0.1	.0000938	0.1	.0000938	0.1	.0000938
1,2,3,4,6,7,8-HpCDF	.00108	0.01	.0000108	0.01	.0000108	0.01	.0000108
1,2,3,4,7,8,9-HpCDF	.00166	0.01	.0000166	0.01	.0000166	0.01	.0000166
1,2,3,4,6,7,8,9-OCDF	.00254	0.0003	.000000762	0.0001	.000000254	0.0001	.000000254
		Total =	.004738612	Total =	.005202024	Total =	.006851824

TEF - Toxicity Equivalent Factors from the World Health Organization (WHO) (Mammal 2005, Fish and Bird 1998).

ATTACHMENT D

- EPA Fact Sheet: Use of Dioxin TEFs in Calculating Dioxin TEQs at CERCLA and RCRA Sites

Use of Dioxin TEFs in Calculating Dioxin TEQs at CERCLA and RCRA Sites

May 2013

Purpose

This fact sheet provides information on the use of the 2005 World Health Organization (WHO) dioxin toxicity equivalence factors (TEFs) to calculate dioxin toxicity equivalence (TEQ) at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) sites contaminated with dioxins, furans, and polychlorinated biphenyls (PCBs). The approach provided in this fact sheet is for use at newly evaluated sites as well as for re-evaluating sites that have been previously cleaned up or screened from further consideration.

Background

Dioxins are a group of compounds that share distinct chemical structures and characteristics. The term dioxin commonly refers to the compound in this group considered most toxic, 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD). Dioxin-like is a description used for compounds that have chemical structures, physico-chemical properties, and toxic responses similar to TCDD. Dioxin-like compounds (DLCs), including polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (PCBs), typically are found in mixtures with TCDD at CERCLA and RCRA sites and other contaminated properties. The EPA Toxics Release Inventory Program issued a final rule (EPA 2007) requiring that facilities report the released mass (grams) of individual DLCs in addition to reporting the released mass of TCDD.

The evaluation of TCDD and DLCs at CERCLA and RCRA sites includes consideration of the toxicity (i.e., cancer risks and non-cancer effects) of these contaminants. In the absence of toxicity values for DLCs, TEFs are used as a measure of the toxicity of the DLCs relative to TCDD. Concentrations of DLCs measured in media are modified by TEFs to determine the dose of each DLC in a medium that is equivalent to a dose of TCDD. The modified DLC doses are expressed in terms of TCDD toxicity equivalence (TEQ). The DLC TEQ concentrations are used, rather than the DLC concentrations measured in media, for site evaluations including site characterization, risk assessment, cleanup level development and confirmatory sampling.

The U.S. Environmental Protection Agency (EPA) Office of Research and Development released the *Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Dioxin-Like Compounds* (EPA 2010), recommending the use of the 2005 human and mammalian WHO TEF values for DLCs. For additional information on the use of the 2005 WHO TEFs at CERCLA and RCRA sites, refer to EPA's 2010 TEF document.

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substitute for statutes that EPA administers or their implementing regulations, nor is it a regulation itself. Thus, this document does not impose legally binding requirements on EPA, the states, or the regulated community, and may not apply to a particular situation based upon the specific circumstances. Rather, the document provides information that may be used at particular sites, as appropriate, given site-specific circumstances.

Frequently Asked Questions

Q: What are toxicity equivalence factors (TEFs)?

A: 2,3,7,8-tetrachlorodibenzo-p-dioxin (or TCDD) and DLCs, including polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (PCBs), typically occur as mixtures in environmental media. The toxicity of DLCs can be addressed by considering their toxicity relative to TCDD. EPA recommends using updated TEFs to assess human health risks from exposure to dioxin-like compounds (EPA 2010). A TEF for a DLC is a measure of the compound's toxicity relative to TCDD, which is assigned a TEF of 1. For example, 1,2,3,4,7,8-hexachloro-dibenzo-*p*-dioxin is considered one tenth as toxic as TCDD and has therefore been given a TEF of 0.1.

Q: For which media are the TEFs used?

A: The TEFs are most appropriate for dioxin exposures via the oral exposure route. Generally, the ingestion pathway for TCDD drives risk CERCLA and RCRA assessments. The TEFs can be used for evaluating the risk posed by the ingestion of soil, sediments, water, and fish contaminated with TCDD and DLCs.

Q: What is the basis for using the TEF approach for DLCs?

A: The TEF approach is based on the concept of dose addition, under which it is assumed that the toxicokinetics and toxicodynamics for all DLCs are similar, and that the DLCs act by a common toxic mode of action (i.e., for all DLCs, effects are mediated through aryl hydrocarbon receptor binding). Further, this approach assumes that toxicological interactions do not occur among the DLCs within the environmental mixtures being assessed (e.g., synergism and antagonism do not occur).

Q: What is toxicity equivalence (TEQ)?

A: For a single DLC, dioxin toxicity equivalence (TCDD TEQ) is the product of the concentration of the DLC in an environmental mixture and its corresponding TEF; total TEQ for the mixture is the sum of the individual TCDD TEQs across the DLCs. The TCDD TEQ provides a means for determining the toxicity of a mixture of DLCs, in the absence of toxicity values for these DLCs.

The EPA's *Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8- Tetrachlorodibenzo-p-dioxin and Dioxin-Like Compounds* (EPA

2010) provides a formula (reproduced below) for calculating the exposure concentration for *n* DLCs in a mixture, in TCDD TEQ. Exposure to the *ith* individual PCDD, PCDF, or PCB compound is expressed in terms of an equivalent exposure of TCDD by computing the product of the concentration of the individual compound (*Ci*) and its assigned *TEFi*. TEQ is then calculated by summing these products across the *n* DLCs present in the mixture.

$$TEQ = \sum_{i=1}^{n} (C_i \times TEF_i)$$

- C_i *Individual TCDD or DLC concentration in environmental media.*
- TEF_i *Toxicity Equivalence Factor assigned for TCDD or the DLC.*
- *TEQ TCDD toxicity equivalence.*

Sample calculation:

Using the 2005 WHO TEFs (Van den Berg et. al. 2006), the TEQ for each DLC is estimated by multiplying the measured DLC concentration by the TEF corresponding to the DLC. The TEQ for the media sample is determined by summing the individual TEQ for TCDD with DLCs in the mixture. For example:

Individual concentration of TCDD and DLCs in an environmental sample:
2,3,7,8 TCDD.....10 ppt (parts per trillion)
2,3,4,7,8- PeCDF .....30 ppt
PCB 126..... 20 ppt

TEFs:
2,3,7,8 TCDD.....1
2,3,4,7,8- PeCDF 0.5
PCB 126.....0.1

Individual TEQ:
2,3,7,8 TCDD.....10 ppt × 1 = 10 ppt TEQ
2,3,4,7,8- PeCDF .....30 ppt × 0.5 = 15 ppt TEQ
PCB 126.....20 ppt × 0.1 = 2 ppt TEQ

Total TEQ
10 ppt + 15 ppt + 2 ppt = 27 ppt TEQ

Q: For which exposure pathways are the TEFs used?

A: In addition to the ingestion pathway, the TEFs may be applied to other exposure routes (i.e., dermal or inhalation), as an estimate, assuming exposures to DLCs via these routes can be quantified. When included in an assessment, the fractional contribution of oral, dermal, and inhalation route exposures to the predicted TEQ should be identified.

In the absence of dermal toxicity values, a route-to-route (oral to dermal) extrapolation can be done using the oral toxicity value and adjusting for absorption through skin. This Office of Solid Waste and Emergency Response policy is described in Section 4.1 of the *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final* (EPA 2004). The availability of a dermal absorption factor for TCDD allows for the use of the TEFs in evaluating dermal exposure.

The EPA Integrated Risk Information System (IRIS) does not include toxicity values for estimating the risk posed by the inhalation of TCDD (either via particulates or volatiles). The EPA Regional Screening Tables (EPA 2012) provide dioxin soil screening levels for the inhalation pathway based on the California EPA reference concentration (RfC) and unit risk factor for TCDD. Inhalation risk based on particulate emissions from soil, estimated using the California EPA RfC for TCDD, shows that the contribution of the inhalation pathway compared to the ingestion pathway is well below 1%.

Q: Are dioxin TEFs applied in assessing both cancer risks and non-cancer health effects?

A: The EPA 2010 TEF document (EPA 2010) recommends that the TEFs be used for all effects mediated through aryl hydrocarbon receptor binding by the DLCs, including cancer and noncancer effects.

Q: How is the EPA 2010 report *Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Dioxin-Like Compounds* to be applied at CERCLA and RCRA sites?

A: The TEF approach has previously been used at CERCLA and RCRA sites. The EPA is now recommending the use of the 2005 human and mammalian WHO TEF values for DLCs, as discussed in the EPA 2010 TEF report (EPA 2010). This report provides updates to the 1998 WHO TEF values (Van den Berg et al 1998), based on a number of factors, including new toxicity values and the need to consider impurities in test compounds.

Some of the 2005 WHO TEFs have increased and some have decreased in value, compared to the 1998 WHO TEFs. The relative importance of the TEF changes largely depends on the mixture being evaluated. For example, the TEF for 2,3,4,7,8-pentachlorodibenzofuran was reduced from 0.5 to 0.3 and the TEF for PCB 169 increased from 0.01 to 0.03. See Attachment A for a comparison of the WHO 1998 and 2005 TEFs.

Underlying assumptions of the TEF method include: a) the toxicokinetics and the toxicodynamics of TCDD and DLCs are similar; b) the dose-response curves of TCDD and DLCs are similarly shaped; c) the aryl hydrocarbon receptor mediates most if not all of the biologic and toxic effects of the DLCs; and d) the kinetics and potency of various DLCs are generally similar between species (EPA 2000, EPA 2008). EPA recommends that risk assessors identify the fraction of the total TEQ attributable to TCDD (for which

uncertainty is relative low) and attributable to DLCs (for which uncertainty is somewhat higher).

Q: The EPA issued a report in 2010 on the use of dioxin TEFs for human health risk assessments. Does the Agency have information on the use of TEFs for ecological risk assessments?

A: Yes. In 2008, the EPA issued the *Framework for Application of the Toxicity Equivalence Methodology* for *Polychlorinated Dioxins, Furans, and Biphenyls in Ecological Risk Assessment* (EPA 2008).

Q: How are the dioxin TEFs used at PCB sites?

A: There are 209 PCB chemical compounds, or congeners; 12 of the 209 PCB congeners are considered dioxin-like. If dioxin-like PCBs are of concern at a PCB site, the PCB cleanup level will need to meet a site-specific dioxin TEQ cleanup level. In this case, two PCB cleanup levels are calculated. One cleanup level is calculated for total PCBs (i.e., for all PCB congeners present), based on toxicity values for total PCBs. The other PCB cleanup level is calculated so that it meets a site-specific dioxin TEQ cleanup level. This second PCB cleanup level depends on the TEQ (i.e., concentration x TEF) of dioxin-like PCBs in the PCB-contaminated media along with any TCDD and other DLCs present, and considers toxicity values for TCDD. The more stringent of the two PCB cleanup levels is selected.

For example, the PCB soil cleanup level that will meet a site-specific dioxin TEQ soil cleanup level can be calculated as:

$$PCB_{\text{cleanup level for TCDD/DLCs}} = PCB_{\text{soil concentration}} \times TEQ_{\text{cleanup level}} / TEQ_{\text{soil concentration}}$$

Where:

- $PCB_{\text{cleanup level for TCDD/DLCs}}$ — PCB soil cleanup level that meets the dioxin TEQ soil cleanup level.
- $PCB_{\text{soil concentration}}$ — Soil concentration of total PCBs.
- $TEQ_{\text{cleanup level}}$ — Dioxin TEQ soil cleanup level.
- $TEQ_{\text{soil concentration}}$ — Soil TEQ concentration of TCDD and DLCs, (i.e. other dioxins, furans and dioxin-like PCBs).

The PCB soil cleanup level that will meet a site-specific dioxin TEQ soil cleanup level is compared to the site-specific soil cleanup level for total PCBs to select the more stringent of the two, ensuring that the remedy will be protective for both PCB and dioxin-like PCB (along with any TCDD and other DLC) exposures.

The following is a sample calculation:

$$PCB_{\text{cleanup level for TCDD/DLCs}} = 5{,}000 \text{ ppt PCBs} \times 50 \text{ ppt TEQ} / 500 \text{ ppt TEQ}$$

$PCB_{\text{cleanup level for TCDD/DLCs}}$ = 500 ppt PCBs

In this example, one tenth of the total PCB concentration is due to dioxin-like PCBs, as well as any TCDD and other DLCs present (i.e., the dioxin-like PCB TEQ concentration, along with any TCDD and other DCLs present, is 500 ppt TEQ). For a soil dioxin cleanup level of 50 ppt TEQ, the corresponding PCB soil cleanup level that would not exceed the soil dioxin cleanup level is 500 ppt PCBs.

Additional Resources

This fact sheet provides information on the use of the 2005 WHO TEFs to calculate TEQs at CERCLA and RCRA sites. Additional information on evaluating TCDD and DLCs at these sites can be found online at: http://epa.gov/superfund/health/contaminants/dioxin/dioxinsoil.html

Attachment A "Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of Polychlorinated Dibenzo-p-dioxins, Dibenzofurans, and Dioxin-Like Polychlorinated Biphenyls" provides the 2005 updates to the 1998 WHO TEFs.

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ATTACHMENT A

Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessment of Polychlorinated dibenzo-*p*-dioxins, Dibenzofurans, and Dioxin-Like Polychlorinated Biphenyls[1]

Compound	1998 TEF[2]	2005 TEF[3]
Polychlorinated dibenzo-*p*-dioxins (*PCDDs*)		
2,3,7,8-Tetrachloro-dibenzo-*p*-dioxin (TCDD)	1	1
1,2,3,7,8-Pentachloro dibenzo-*p*-dioxin (PeCDD)	1	1
1,2,3,4,7,8-Hexachloro- dibenzo-*p*-dioxin (HxCDD)	0.1	0.1
1,2,3,6,7,8-Hexachloro- dibenzo-*p*-dioxin (HxCDD)	0.1	0.1
1,2,3,7,8,9-Hexachloro- dibenzo-*p*-dioxin (HxCDD)	0.1	0.1
1,2,3,7,8,9-Heptachloro- dibenzo-*p*-dioxin (HpCDD)	0.01	0.01
Octachloro-dibenzo-*p*-dioxin (OCDD)	**0.0001**	**0.0003**
Polychlorinated dibenzofurans (*PCDFs*)		
2,3,7,8-Tetrachlor-dibenzofuran (TCDF)	0.1	0.1
1,2,3,7,8-Pentachloro-dibenzofuran (PeCDF)	**0.05**	**0.03**
2,3,4,7,8-Pentachloro-dibenzofuran (PeCDF)	**0.5**	**0.3**
1,2,3,4,7,8-Hexachloro-dibenzofuran (HxCDF)	0.1	0.1
1,2,3,6,7,8-Hexachloro-dibenzofuran (HxCDF)	0.1	0.1
1,2,3,7,8,9-Hexachloro-dibenzofuran (HxCDF)	0.1	0.1
2,3,4,6,7,8-Hexachloro-dibenzofuran (HxCDF)	0.1	0.1
1,2,3,4,6,7,8-Heptachloro-dibenzofuran (HpCDF)	0.01	0.01
1,2,3,4,7,8,9-Heptachloro-dibenzofuran (HpCDF)	0.01	0.01
Octachloro-dibenzofuran (OCDF)	**0.0001**	**0.0003**
Polychlorinated biphenyls (*PCB* congener number)		
3,3',4,4'-Tetrachloro-biphenyl (77)	0.0001	0.0001
3,4,4',5-Tetrachloro-biphenyl (81)	**0.0001**	**0.0003**
3,3',4,4',5-Pentachloro-biphenyl (126)	0.1	0.1
3,3',4,4',5,5'-Hexachloro-biphenyl (169)	**0.01**	**0.03**
2,3,3',4,4'-Pentachloro-biphenyl (105)	**0.0001**	**0.00003**
2,3,4,4',5-Pentachloro-biphenyl (114)	**0.0005**	**0.00003**
2,3',4,4',5-Pentachloro-biphenyl (118)	**0.0001**	**0.00003**
2',3,4,4',5-Pentachloro-biphenyl (123)	**0.0001**	**0.00003**
2,3,3',4,4', 5-Hexachloro-biphenyl (156)	**0.0005**	**0.00003**
2,3,3',4,4',5'-Hexachloro-biphenyl (157)	**0.0005**	**0.00003**
2,3',4,4',5,5'-Hexachloro-biphenyl (167)	**0.00001**	**0.00003**
2,3,3',4,4',5,5'-Heptachloro-biphenyl (189)	**0.0001**	**0.00003**

[1] Numbers in bold indicate a change in TEF value.
[2] Source: van den Berg et al. (1998); available at: http://www.cerc.usgs.gov/pubs/center/pdfDocs/90970.pdf
[3] Source: van den Berg et al. (2006); WHO's Web site on dioxin TEFs, available at: http://www.who.int/ipcs/assessment/tef_update/en/